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FOR CONSIDERATION -- IMPROVEMENTS TO THE RESEARCH AND DEVELOPMENT CYCLE

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SUMMARY

Although there is a wealth of written material on research and development, the proposals for change contained therein are often too numerous and sweeping. This paper enumerates ways in which the Army's research and development cycle may be improved with the minimal expenditure of resources.

No change in Army organization was made subsequent to World War II until 1954-1955 when the positions of Deputy Chief of Staff for Logistics and Deputy Chief of Staff for Plans and Research were established. Several other minor changes preceeded the implementation, on 10 January 1962, the Project 80 Report which abolished the technical services and established the Army Materiel Command.

The objective of Army research and development is to develop the best equipment for the Army in the shortest period of time. Both speed and quality are prime characteristics of Army research and development.

The research portion of the cycle begins with the preparation of long range plans and a determination of the equipment needed to complement these plans. It ends when direction is received to translate the equipment requirements into hardware. An analysis of the research portion reveals a need for uniform procedures for staffing materiel requirements, for extreme reluctance to change requirements, for a firm basis of issue for new items. Materiel requirements must be adequate, complete, and realistic.

The development portion of the cycle begins with the formulation of the engineering concept and terminates with type classification. This portion of the cycle can be improved with further emphasis on commodity management, simultaneous and continuous testing, and assignment of better qualified personnel to test boards.

The research and development cycle can be improved by implementation of the measures recommended in this paper.

CHAPTER 1

INTRODUCTION

A cursory examination of writings pertaining to research and development will reveal a spectrum extending from cogent articles,[1] through US Army War College student theses,[2] to lengthy and learned books by well-known authorities.[3,4] All have much to say, most present studied prose, many have valid recommendations. Certainly a sorting and digestion of their recommendations would produce a listing of "dos" and "don'ts" which if adopted would produce measurable improvements of the Army's research and development effort.

The above conclusion leads one to speculate why, if these proposals are available and logically substantiated, is there not a rapid scurrying to implement these changes. Basically the answers are twofold. One answer, and not particularly the primary one, is that there is such a mass of material that one could find support for almost any change desired. The other basic answer is that the proposals for change are often too sweeping. Some require

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[1]Harvey H. Fischer, "Reducing Lead Time," Army Information Digest, Volume 17, April 1962, pp. 47-53.

[2]William Teir, Critical Analysis of Organization of the Army for Research and Development.

[3]Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis.

[4]James M. Gavin, War and Peace in the Space Age.

sizeable expenditures of funds; others require major organizational changes, deletions and additions. These major changes, even the most efficacious and highly tauted at best could take place only after a passage of considerable time.

This thesis examines the Army research and development cycle with the sole purpose of discovering ways, immediately implementable, of improving the cycle; and it is based on the author's research and experience as a Department of the Army Research and Development Specialist. Especial emphasis will be placed on the discovery of improvements which could be implemented with a minimum of additional expenditures of men, money, and materials.

CHAPTER 2

HISTORY OF ARMY RESEARCH AND DEVELOPMENT

THE DAVIES COMMITTEE

The Davies Committee on Army Organization reported, in 1953, deficiencies in the Army's logistics organization among a listing of primary shortcomings.[1] It recommended an integration of the Army logistics activities by the creation of a unified supply command.[2]

For many years, an Army Supply Command has had supporters; but, excepting the war years, such a command has never been established. In both World Wars, an overall logistics command was created after hostilities began, and then only out of necessity. However, these creations suggested the need for a permanent materiel supply organization; since, it was reasoned, all Army organization should be pointed to the day it would be required in war. During the 1954-1955 Army reorganization, the position of Deputy Chief of Staff for Logistics was established on 8 September 1954[3] and the position of Deputy Chief of Staff for Plans and Research was established on 6 October 1955.[4] The purpose of these new positions was the unification of the logistical and research activities of the US Army.

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[1]US Dept of the Army, Advisory Committee on Army Organization, Report of the Advisory Committee on Army Organization, pp. 43-55.
[2]Ibid. pp. 13-14.
[3]US Dept of the Army, General Order 66, Section I.
[4]US Dept of the Army, General Order 57, Section II.

DEPUTY CHIEF OF STAFF FOR LOGISTICS (DCSLOG)

The purpose in creating the position of Deputy Chief of Staff for Logistics was to combine the seven technical services: the Quartermaster Corps, Engineer Corps, Signal Corps, Medical Corps, Chemical Corps, Ordnance Corps, and Transportation Corps. This attempt to integrate the technical services failed and left the equivalent of seven separate supply services. Together, but separately, they were that element of the Army in the Continental United States with the overall "wholesale" logistics mission. The Deputy Chief of Staff for Logistics was responsible for all Army logistics matters and operated under the functional supervision of the Assistant Secretary of the Army for Installations and Logistics. All matters concerning the technical services excepting those relating to research and development were controlled by this office.[5]

CHIEF OF RESEARCH AND DEVELOPMENT (CRD)

A later readjustment in staff positions replaced the Office of Deputy Chief of Staff for Plans and Research with that of the Chief of Research and Development. This change established the Chief of Research and Development as one of the Deputy Chiefs of Staff, under the functional supervision of the Assistant Secretary

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[5]US Dept of the Army, Army Regulation 10-5, 22 May 1957, p. 12 (refarred to hereafter as AR 10-5).

of the Army for Research and Development. The Chief of Research and Development had the responsibility to direct and supervise all Army research, development, test, and evaluation of materiel. This directorate had control over the chiefs of the seven technical services within these areas of responsibility. Consequently, the technical services received direction from two staff organizations in Headquarters, Department of the Army.[6]

CONTINENTAL ARMY COMMAND

In addition to his responsibilities for tactics and doctrine, the Commanding General of the US Army Continental Army Command (CONARC) had some important materiel development responsibilities.[7] These responsibilities were a continuation of those assigned to the former Chief of Army Field Forces. They included the preparation of requirements for new materiel and the supervision of the user testing conducted by the Artillery Board, Armor Board, Infantry Board, Air Defense Board, Communications and Electronic Board, Aviation Board, and the environmental testing agencies in Alaska and Panama. These boards and agencies were subordinate commands of CONARC and reported to and were directly controlled by CONARC. Hence, a third element of the Army was responsible for some of the important aspects of Army materiel development.

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[6] Ibid.

[7] US Depts of the Army and the Navy, Special Regulations 10-1-1, pp. 19, 20.

TECHNICAL SERVICES ORGANIZATION

The technical services were organized to implement the operational philosophy of commodity assignment. Individual technical service responsibility was established vertically for all phases of the creation, design, fabrication, test, and fielding of new materiel.[8] The commodity managers were the seven technical services chiefs. Because of the broad spectrum of its responsibilities, the Ordnance Corps had organized its subordinate commands into mid-management commodity agencies. Various combinations of functional and commodity commands were to be found throughout the technical services. The consequence of this was that it was difficult, and in some cases virtually impossible, to match the functions and procedures of the seven technical services.

TECHNOLOGICAL GROWTH

The positive exponential growth of technology[9] was accompanied by a similar growth of the technical services missions on research and development. It became the rule rather than the exception that, because of the new complexity of major materiel development programs, the combined services, resources, and talents of more than one technical service were required. In these cases,

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[8] AR 10-5, pp. 18-20.

[9] Arthur W. Radford, The Technology Race, pp. 1-7.

functional responsibilities were difficult to formulate because of the divergent views, varied and vested interests, and differing procedures of the various technical services. Both the necessary and bureaucratic requirements for coordination increased lead times during all phases: concept, development, fabrication, test, standardization, and issue to troops. There were areas where different technical services were accomplishing nearly identical functions in research, development, procurement, storage, management, inventory, distribution, maintenance, and disposal of materiel. No wonder that this materiel mission, the absolute pulse beat of the Army's logistic system, was the one receiving the sharpest, poignant, and most pointed criticism.

This criticism came from all quarters: key Department of Defense persons, members of the Congress, and industry. It was from the industrial element that some of the strongest criticism was heard. Industrialists found the system cumbersome, nearly impossible to understand, and one that varied from technical service to technical service. Integration of materiel efforts was difficult in the DCSLOG-CRD dual authority situation. Also, the relationships between the two staff chiefs as well as other general staff agencies, other elements, and subordinate commands, was affected. Some eight years after the Davies Committee reported its findings, another study group, called Project 80, focused its attention on the Army.

PROJECT 80 REPORT

It came to be recognized as essential that timely reactions to higher, lateral, and subordinate headquarters, were essential. Regretfully, the existing system of materiel and logistical management was not providing the optimum means for required response to higher, lateral, and subordinate authorities. The continuation of the technical services as they existed would have continued to prevent the cohesiveness so necessary. Further, the organizational structure for materiel, the duality of command, the nearly autonomous nature of the technical services were considered the loci of the problem and these loci were the focal points of the study addressing the functions, organization, and procedures of the Department of the Army.[10]

On 10 January 1962, as a direct consequence of the Project 80 Report, the Secretary of Defense directed implementation of four steps culminating in the activation of the Army Materiel Command. The Secretary directed abolition of the offices of the technical services, transfer of the functions of these offices to the Secretary of the Army, accomplishment of the transferred functions to be conducted by such agencies as decided upon by the Army

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[10]US Dept of the Army, Study of the Functions, Organization and Procedures of the Department of the Army, OSD Project 80 (Army). Part 1, Overall Report, FOR OFFICIAL USE ONLY.

Secretary, and provision for orderly and logical transfer of functions during the transitional period.[11]

ESTABLISHMENT OF THE ARMY MATERIEL COMMAND

The Offices of the Chief of Research and Development, Deputy Chief of Staff for Logistics, and the chiefs of the seven technical services were primarily involved in the reorganization of the materiel structure of the Army. The newly created US Army Materiel Development and Logistics Command and the US Army Combat Developments Command partially absorbed these offices. The transfer of responsibilities was envisioned to involve three phases: the first was a six months planning phase, the second was a six months transfer of materiel responsibilities phase, and the third was a six months modification of command internal structure phase. The US Army Materiel Development and Logistics Command, redesignated as the US Army Materiel Command, became fully operational on 10 July 1963.

MISSION OF THE ARMY MATERIEL COMMAND

The US Army Materiel Command, organized as shown in Annex A, has prime responsibility for implementation of the research and development cycle. Its mission includes performing the following assigned materiel functions of the Department of the Army:

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[11]US Dept of the Army, Office of Military History, Reorganization of the Army 1962, pp. 8-81.

research and development; maintenance, production and production engineering; testing and evaluation; procurement and production; integrated materiel inventory management; technical intelligence; and, as related to the Continental United States, wholesale supply and maintenance system.[12]

FUNCTIONS OF THE ARMY MATERIEL COMMAND

The functions performed by the Army Materiel Command to accomplish the foregoing mission are:

a. Assist the Department of the Army General Staff in the formulation of the Army Materiel Program.

b. Conduct and contract for necessary technical intelligence; research; development; engineering, test, evaluation, production, and procurement of materiel; inventory management; and distribution, maintenance, transportation, and disposition of materiel.[13]

SUBORDINATE COMMANDS OF THE ARMY MATERIEL COMMAND

Annex B depicts the subordinate commands of the US Army Materiel Command.

The Electronics, Missile, Mobility, Munitions, and Weapons Commands exercise integrated commodity management of equipments

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[12]US Dept of the Army, Army Regulation 10-11, p. 1.
[13]US Dept of the Army, US Army Materiel Command, AMC Regulation 10-39, July 1963 w/c March 1964, p. I-1.

and systems falling within their areas of responsibilities. Commodity management includes:

a. Design and development.

b. Product, production, and maintenance engineering.

c. Procurement, production, and industrial mobilization planning.

d. Cataloging and standardization.

e. Wholesale inventory management and supply control.

f. Such stock control, storage, distribution, surveillance, depot maintenance, and disposal responsibilities as may be assigned.

g. New equipment training, design of pertinent training devices, and technical assistance to users.

h. Basic and applied research with respect to assigned materiel development.[14]

The Supply and Maintenance Command is responsible for stock control, storage, distribution, depot maintenance, transportation, and disposal of Army-controlled materiel and supplies. This command also has commodity item responsibility for subsistence, general supplies, petroleum products, and clothing and textile materiel.

The responsibilities of the US Army Test and Evaluation Command (USATECOM) are engineering, service, engineering/service, check, confirmatory, and environmental tests and evaluations;

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[14] Ibid pp. I-2 - I-5.

supporting engineer design, production and post-production tests; and participation in troop test planning.[15] The organization of USATECOM is shown in Annex C.

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[15] Ibid, p. I-6.

CHAPTER 3

OBJECTIVE OF ARMY RESEARCH AND DEVELOPMENT

The ultimate objective of Army research and development is:

> to develop weapons, equipment, and techniques for the Department of the Army qualitatively superior to those of any potential enemy, in any environment, and under all conditions of war, thus enabling the Army to carry out its national security missions with maximum effectiveness.[1]

This objective is achieved by focusing upon the development of materiel to satisfy the Department of the Army Qualitative Materiel Requirements (QMR), achievement of Department of the Army Qualitative Materiel Development Objectives (QMDO), conduct of research in areas of promise, and dissemination and use of research results.[2]

IMPORTANCE OF SPEED

An unwritten tenet of the above ultimate objective of Army research and development is the requirement for speed of execution of all undertakings. Planners and operators are directed to take any authorized action in the reduction of time required to satisfy a materiel requirement. A development leadtime goal of four years OR LESS has been established for the period from the initiation

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[1] US Dept of the Army, Army Regulation 705-5, p. 1 (referred to hereafter as AR 705-5).

[2] Ibid, p. 1.

of development effort in the engineering development-operational system development category to type classification.[3]

A great proponent of lead time reduction was Lieutenant General Arthur G. Trudeau, who succeeded Lieutenant General James M. Gavin as US Army Chief of Research and Development on 1 April 1958.[4] General Trudeau evinced real concern in the possibility of the shifting overnight of military advantage to the side that can more rapidly conceive new weapons and place them in the hands of their troops. He stated quite firmly that the advantage goes to the nation whose short lead time allows it not only to counter the enemy's new weapons but also to provide new weapons superior to those of the enemy.[5]

This serious interest in the timely acquisition of equipment has continued. On 25 October 1965, General Creighton W. Abrams, the Vice Chief of Staff, US Army, indicated the desire of the Secretary of the Army that a comprehensive review of Army test and evaluation practices be conducted.[6] There is no more important place to begin an economy of time than during the research portion of the cycle.

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[3]US Dept of the Army, Army Regulation 11-25, pp. 1-2.

[4]US Dept of the Army, Research and Development Division, Path of Progress, p. 11.

[5]Arthur G. Trudeau, "Lead Time--An Essential of Survival," Army, Navy, Air Force Journal, Vol. XCVI, 10 Jan. 1959, p. 1.

[6]Creighton W. Abrams, Letter to CG, CONARC and others, 25 Oct. 1965, p. 1. FOR OFFICIAL USE ONLY.

CHAPTER 4

RESEARCH PORTION OF THE CYCLE

BEGINNING OF RESEARCH

Annex D shows the research portion of the schedule of research and development events. Research events begin with the preparation of the Basic Army Strategic Estimate,[1] the Army Research and Development Long Range Plan,[2] and the Army Long Range Technological Forecast.[3] These documents and others provide definitive guidance for scheduling research and development and state broad qualitative requirements of the Army. Based on these documents and the recommendations of a command or agency for a new developmental objective, a Qualitative Materiel Development Objective (QMDO) is established.[4] The QMDO is an approved statement of a military need for development of new materiel, the feasibility of which cannot be determined sufficiently to permit the establishment of a Qualitative Materiel Requirement (QMR). The QMDO furnishes a guide for the direction of research efforts. As these efforts approach success, the QMDO evolves into one or

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[1]US Dept of the Army, Deputy Chief of Staff for Military Operations, Basic Army Strategic Estimate for the Period 1963-1983 (U), TOP SECRET NOFORN.

[2]US Dept of the Army, Office of the Chief of Research and Development, The Research and Development Long Range Plan (U), SECRET NOFORN.

[3]US Dept of the Army, Office of the Chief of Research and Development, Long Range Technological Forecast (U), SECRET NOFORN.

[4]AR 705-5, p. 12.

more QMR's or Small Development Requirements (SDR's). A QMR is a statement of military need for a new item, system, or assemblage, the development of which is believed feasible. The QMR states the Army's major materiel needs in terms of military characteristics and priorities and relates materiel to the operational and organizational context in which it will be used.[5] A SDR states an Army need for the development of equipment of proved feasibility which can be developed in a short time, and because of low cost and simplicity of development does not warrant the establishment of a QMR.

COMBAT DEVELOPMENTS COMMAND ACTIONS

The Commanding General, US Army Combat Developments Command (USACDC), is responsible for the preparation and submission to Headquarters, Department of the Army, for approval, all QMR's for materiel to be used by the Army in the field.[6] Army commands and agencies may prepare QMR's and SDR's in the form of recommendations to USACDC. USACDC reviews and comments on the proposed QMR's and SDR's and forwards them to the Chief of Research and Development for Army staff review, coordination, approval, and modification. The coordinated QMR's are submitted to the Materiel Requirements Review Committee for final review to determine validity,

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[5] Ibid, pp. 13-15.
[6] Ibid, p. 13.

requirement for a total feasibility study, intent to initiate a project, and priority, before granting Department of the Army approval. During this review, the committee selects those items for which a total feasibility study must be conducted.

TOTAL FEASIBILITY STUDY

As the name connotes, the total feasibility study consists of an examination of the myriad facets envolved in a feasibility determination.[7] Forecasts of total funded and unfunded costs include the determination of the capability of supporting the project within foreseeable research, development, test, and evaluation funding levels. The acquisition objectives are established and the capability to purchase within the predictable procurement period is determined. The qualitative and quantitative personnel implications are studied. Finally the operational implications are considered. In addition to personnel from the Office of the Chief of Research and Development, the total feasibility study group includes representation from the developing agency, the Deputy Chief of Staff for Logistics, the Deputy Chief of Staff for Personnel, the Comptroller of the Army, and the Deputy Chief of Staff for Military Operations.

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[7] AR 705-5, p. 17.

PROJECT INITIATION

The project is initiated by approval of the proposed QMR or SDR by Headquarters, Department of the Army. On items for which a total feasibility study is required, Headquarters, Department of the Army, directs project initiation when so recommended by the Materiel Requirements Review Committee after a review of the completed study.

COMBAT DEVELOPMENT OBJECTIVES GUIDE

Published in the Combat Development Objectives Guide is a reference to the approved QMR or SDR.[8] Component development and applied research projects are initiated and conducted in consonance with the approved QMDO, QMR, or SDR. The developing agency at the direction of Headquarters, Department of the Army, initiates a development project responsive to the approved QMR or SDR and indicates whether formal "in process" reviews are to be conducted.

In consideration of the desirability of maintaining a reasonable balance between development time, cost, and adequacy of materiel to fulfill its purpose, a number of criteria must be applied to all requirements. These criteria are:

a. Preclusion of unnecessary features which add to cost, complexity, and maintenance requirements.

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[8] US Dept of the Army, Combat Development Objectives Guide (U), SECRET, RESTRICTED DATA, NOFORN.

b. Attainability of all components taking maximum advantage of state of the art.

c. Optimal time, cost, and quality trade-offs during the establishment of QMR's.[9]

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[9] AR 705-5, p. 3.

CHAPTER 5

DEVELOPMENT PORTION OF THE CYCLE

BEGINNING OF DEVELOPMENT

Formulation of engineering concept and design characteristics is the beginning of the actual development project which is outlined in Annex E. The completed design is approved and released for fabrication of prototypes (pilot models). Termination of this phase of development is reached upon receipt of prototypes. During this phase, engineer design tests are performed to determine inherent structural, electrical, or other physical and chemical properties of construction materials, component, subassembly, or prototype assembly, item or system, and includes effects of environmental stresses of these properties.[1] At completion of this phase, research and development acceptance tests are conducted to guarantee that specifications of the development contract have been fulfilled by the prototype.

TESTING

The process of development requires evaluation of the product by testing to obtain performance data and to determine whether the product is satisfactory for its ultimate use. During this stage, the pilot model undergoes engineering, service, and

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[1]US Dept of the Army, Army Regulation 70-10, p. 3 (referred to hereafter as AR 70-10).

environmental testing. The technical performance and safety characteristics of an item or system and its associated tools and test equipment as described in the QMR or SDR and as indicated by the particular design are determined during the engineering tests.[2] Further, this test provides data for use in further development and for determination as to the technical and maintenance suitability of the item or system for service test. The service tests determine the degree to which the item or system and its associated tools and test equipment perform the mission as described in the QMR or SDR, and the suitability of the product and its maintenance package for Army use.[3] Environmental tests determine if the product performs effectively in the environments of its intended use. Environmental testing is normally conducted as an integrated engineer/service test. The basis for type classification, which is the last event in the research and development cycle, is the results of the service tests.

TYPE CLASSIFICATION

Materiel is type classified to provide the basis upon which to determine the present qualitative adequacy of Army materiel.[4] It is used to record the status of an item in relation to its

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[2] Ibid., p. 3.
[3] Ibid., p. 3.
[4] AR 700-20, p. 1.

overall life history and to plan and execute its procurement, issue, maintenance, and disposal. The Technical Committee determines the type classification of an item. Depending on the category of type classification authorized, the item may be returned to the developing agency for further development or adopted as standard and prepared for production.

TECHNICAL COMMITTEE SYSTEM

The technical committee system is the method used to effect coordination, approval, and recording of actions and decisions pertaining to research, development, test and evaluation, type classification, transfers of logistical responsibility, and other decisions relating to materiel.[5] The technical committee is composed of representatives of the prime developing agency, of other Army developing agencies when deemed necessary by the heads of these agencies, of the Secretary of the Army and of the Army General Staff provided by the Chief of Research and Development. The chairman is the representative of the prime developing agency. Each member agency of the technical committee has one vote. The invited representatives of other interested agencies attend as authorized observers without vote.

The technical committee, which meets at least once each fiscal quarter, takes either formal or read-for-record action on

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[5]US Dept of the Army, Army Regulation 705-9, p. 1.

matters placed before it. Formal actions are those requiring the concurrences of all interested members, or requiring approval of higher authority. Included in such matters are project and task initiation or termination; approval of technical characteristics, engineering concepts, and design characteristics; actions which will change the scheduled date of type classification or release for initial production by one fiscal quarter or more; actions which require funding changes in amounts above the reprogramming authority of the head of the developing agency; decisions on type classification or reclassification of materiel; and changes in the Department of the Army priority of projects and tasks. Read-for-record action is the recording of Department of the Army staff decisions or other actions which require neither the concurrence of all interested agencies nor the approval of higher authority, but which are of sufficient importance to be duly recorded according to committee procedures. The research and development cycle is complete when type classification by the technical committee is accomplished.

CHAPTER 6

ANALYSIS OF THE CYCLE

FUNDS

Any analysis of the research and development cycle must be prefaced by a discussion of funds alloted for research and development. For Fiscal Year 1966, the Army requested a total obligational authority of $1.46 billion for research and development, some 22 percent of the total Department of Defense budget for this category of expenditure.[1] During the past four years, the Army has received an average of 20 percent of the total Department of Defense budget for this category of expenditure. On the surface, the Army request for $67 million more than the amount allocated in the Fiscal Year 1965 budget appears more than adequate.

But when one penetrates the surface, other facts mainfest themselves. Beginning with the Year 1962, the year to year growths of Defense research and development funds were 11 percent,[2] zero percent,[3] minus eight percent,[4] and one percent,[5] respectively.

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[1] Harold K. Johnson, Statement by Chief of Staff, US Army. . ., p. 14.

[2] US Bureau of the Budget, The Budget of the United States Government; Department of Defense Extract; Fiscal Year Ending June 30, 1964, pp. 288-290.

[3] US Bureau of the Budget, The Budget of the United States Government; Department of Defense Extract; Fiscal Year Ending June 30, 1965, pp. 282-283.

[4] US Bureau of the Budget, The Budget of the United States Government; Department of Defense Extract; Fiscal Year Ending June 30, 1966, pp. 311-313.

[5] Ibid, pp. 311-313.

The total national research and development funds, including both defense and industry, have had an annual growth of five percent during the past four years.[6] This growth rate is less than half what it was a few years ago;[7] and, among some industralists, there are real fears that research and development activities are leveling off and could possibly decline in the immediate future. The above statistics must be viewed in this prospective: the gross national product grew five percent annually over the past four years.[8]

Funds are the life-blood of research and development, and the Army depends on scientific and technological advances to remain a prime contestant in the race for superiority. The plateau which it appears has been reached is apparent from the figures already stated. One shares the concern of the President and the Secretary of Defense that too much spending courts inflation, but funds alloted to research and development must increase at a rate at least equal to any other growth rate in the economy.

The nation has been warned by Dr. Charles S. Draper of the Massachusetts Institute of Technology that continuing attention

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[6]Victor J. Danilov, $21-Billion for Research", Industrial Research, Vol 7, Jan 1965, p. 27.

[7]Ibid, p. 27.

[8]According to President Johnson, US Bureau of the Budget, The Budget. . . June 30, 1966, op. cit., p. 8.

must be directed toward improvements in advanced technology to assure a satisfactory position in world competition. He, along with Dr. H. W. Ritchey, President of Thiokol Chemical Corporation, worry that any scientific and technological lag would seriously affect the defense posture as well as every aspect of our economy.[9]

It is realized that a greater percentage increase in the research and development dollar does not produce automatically an increase in quality or quantity of discoveries, innovations, and products. However, with an increase in funds, it is a certainty that the chances for significant advances would increase, and the United States would continue to add to its important foundation for growth. Since an increase in the research and development dollar would involve sizeable expenditures, it is not included as a recommendation.

REQUIREMENTS ESTABLISHMENT AND REVIEW

Current publications contain the criteria needed for establishment of good requirements as well as procedures for review and processing of requirements to insure development of quality materiel in a timely fashion.[10] However, though sequential procedures are prescribed, some requirements are processed and

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[9] "Editorial: Real or False Economy", Industrial Research, Vol. 7, Jan. 1965, p. 7.

[10] AR 705-5, p. 3.

approved in short periods of time, whereas others seem to languish.

There is a large range of costs among the numerous items in the research phase of development. Certainly those few items absorbing the greatest expenditure of resources are the ones which require most attention from researchers, planners, and managers of the defense effort. During the research on the Pershing Missile, General Decker, then Chief of Staff of the Army, and Lt General Colglazier, then Deputy Chief of Staff for Logistics, were questioned carefully by member of Congress concerning the requirement for such a weapon, its all-weather capability, concept of future deployment, and a detailed status report. Their testimony indicated careful consideration of all these factors.[11]

However, during the same hearing,[12] Mr. Mahon questioned Secretary of the Army Stahr and General Decker concerning a widespread feeling in the Congress that the Army took too long in both developing new weapons and placing them in the hands of troops. The case in point was the M-14 Rifle. It was admitted that the development of the M-14 Rifle had not proceeded in an expeditious manner. There appeared to be no urgency for the

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[11]US Congress, House, Committee on Appropriations, Department of Defense Appropriations for 1962, pp. 196-197.

[12]Ibid., pp. 170-175.

addition of this weapon to the inventory. Further, there was no evidence that a planned inventory level for the new M-14 Rifle had been established.

A uniform procedure is needed for the staffing actions incident to the timely establishment and approval of materiel requirements. It is recognized that there are priority projects, projects whose development and fielding will have a major impact on the defense posture.[13] Other projects, not so glamorous and costly, should not be condemned to military limbo for lack of uniform procedures for staffing actions.

CHANGING OF REQUIREMENTS

There is a temptation on the part of the developer and the user to change requirements during the development phase because of breakthroughs, advances in state of the art, or improved technologies. Often the developer is faced with a decision as to whether a technological innovation should be adopted. Most appealing to the user are advances in state of the art or a superior version of a component which offers promise of extending the capability of a weapon under development. Too often adoption of a major new development in one portion of a system will require realignment of the entire system.

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[13]Seymour J. Deitchman, Limited War and American Defense Policy, pp. 133-134.

Although Dr. Harold Brown, Director of Defense Research and Engineering, anticipated in May 1963 that the request for Mauler funds was likely to be too conservative, and anticipated some technical troubles in the Mauler development,[14] the developers decided on a major system change.

An advancement in state of computer art made the original computer for the Mauler system appear workable but rather primitive. Availability of a smaller, more sophisticated computer with a greater capacity, was considered reason enough for its adoption. The development work associated with the original computer was not adequate for adoption of the new computer, and further development work was required. Confidence must be evinced in the initial technology and development theories selected, and the temptation to change must be conquered.

The absence of a central clearing house to resolve changing of requirements was in evidence in the 107mm XM 95 Mortar Program.[15] An In-Process Review (IPR) of the system was held to resolve the questions about the future development effort on ammunition and to initiate immediately engineering and service tests of the mortar with standard 4.2" mortar ammunition. During the IPR, conflicts were discussed concerning the existing QMR, the capabilities of the present 107mm mortar, and requirements as they

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[14]US Congress, House, Committee on Appropriations, Department of Defense Appropriations for 1964, pp. 15-16.

[15]US Army, Weapons Command, Data Sheets and Minutes of the In-Process Review Meeting on the 107mm Mortar/Ammunition (U). CONFIDENTIAL

presently exist for a mortar system. A complete reorientation of the program was considered. Representatives of the Combat Developments Command and the Assistant Chief of Staff for Force Development favored the development of an entirely new super lightweight mortar system, possibly even of a different caliber. The consequence of such actions was slippage of the development schedule.

There is another side to the coin which deserves investigation. This other side reveals that real improvements can be made by changes which improve a developmental system by application of all current advances within the state-of-the-art. A current example of such a project is the antiballistic missile project whose major components are Nike-Zeus, Nike-X, and Sprint.

In 1963, Dr. Harold Brown reported the Nike-Zeus system was in a sufficiently developed configuration that it could have been deployed any time during the last few years.[16] As the decision for deployment continued to be deferred year after year, the developer did not remain idle.

The Nike-Zeus defense center, reported by Dr. Brown as ready for deployment, consisted of a large acquisition radar, a discrimination radar, several target track radars, a large number of missile track radars, and a quantity of Nike-Zeus missiles.

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[16]US Congress, House, Committee on Appropriations, Department of Defense Appropriations for 1964, p. 7.

There were separate radars for required functions of acquisition, discrimination, target track, and missile track. As months changed into years, the Nike-Zeus system was abandoned in favor of Nike-X except where further research and development of Nike-Zeus would ultimately contribute to Nike-X.[17]

Nike-X in its design formulation stage has a defense center consisting of one multiple array radar, a computing center, a few target track radars and Zeus missiles, and a large number of new Sprint missiles. Development allowed by lack of decision to deploy, coupled with availability of additional funds, is producing a more sophisticated radar and a new concept utilizing two different missiles.[18] The multiple array radar performs functions of acquisition, discrimination, and target track radars; and it eliminates requirement for these three separate equipments.

Improvements indicated in the preceeding paragraph were well thought out, formally reviewed, and detailed cost data were developed. Testimony of Dr. F. J. Larson, Lt Gen D. E. Beach, and the Nike-Zeus expert, Lt Col C. J. Le Van, showed the magnitude of planning that was reached in arriving at the decisions concerning the antiballistic missile program of the Army.[19]

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[17]US Congress, House, Committee on Appropriations, Department of Defense Appropriations for 1966, pp. 348-351.

[18]US Congress, House, Committee on Appropriations, Department of Defense Appropriations for 1963, p. 6.

[19]Ibid., pp. 259-272.

Before full weapon system development was begun in the Nike-Zeus field, cost-effectiveness studies as well as technical studies were conducted. Careful consideration and planning on the part of defense personnel together with the contractors took place during this phase. These studies permitted clear program definition, assessment of technical risks, determination of estimated costs, and formulation of a tentative time schedule. Finally the important judgment of how well the proposed system could contribute to the achievement of military objectives was made.[20]

There is a requirement to formalize the review and approval of proposed major changes in a system. Upgrading requirements should be allowed only after a formal review by an established committee. This review should consider all implications of any proposed change and particularly its impact on approved schedules and consequently upon lead time. Considerations should include improved combat effectiveness, funding aspects, and the rapidity of change in the technology involved.

When a formalization is made as in the Nike-X program in the review and approval procedures prior to a system change, one finds orderly development and improvement; lack of such formalization produces the disorder evident in the difficult Mauler system.

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[20]Charles J. Hitch, Decision-Making for Defense, pp. 75-76.

BASIS OF ISSUE

Any consideration of the improvement of the cycle must include a reference to the Basis of Issue. An established Basis of Issue (BOI) is a requirement for Type Classification action and is a necessary parameter in the development of the Army Materiel Plan.[21] The Qualitative Materiel Requirement contains a tentative Basis of Issue; however lack of a firm BOI delays Type Classification action. Before the eventual cancellation of the project for the Aviation Tent, the project encountered an approximate seven months slippage because there was no firm BOI. The GOER project, which has received much publicity recently, has no established Basis of Issue.

The Qualitative Materiel Requirement for the GOER vehicle project states an operational concept and a postulation of the type tactical and logistical vehicles, presently in the inventory, which GOER will replace.[22] However, before formal Type Classification, a firm Basis of Issue must be formulated and approved.

The above discussion on BOI is included as a "for instance" of how a seemingly minor facet of the cycle can contribute to longer lead time. Often the problems of research and development

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[21]US Dept of the Army, Army Regulation 700-20, p. 9 (referred to hereafter as AR 700-20).

[22]US Army, US Continental Army Command, Qualitative Materiel Requirement for Vehicle, Tactical and Logistical, High Mobility.

compounded by shortages of funds overshadow small but important considerations. The decision concerning BOI is easy to delay because it has already been considered in the QMR document, but it has been considered only tentatively. Orderly development dictates early consideration of BOI in anticipation of expeditious Type Classification action.

MATERIEL REQUIREMENTS

To develop an item of equipment or an entire system properly it is essential that the materiel requirements be adequate, complete, and realistic. In the test of equipment, the US Army Test and Evaluation Command determines to what degree the tested equipment meets the military characteristics expressed in the QMR or SDR, and it determines the suitability of equipment and its maintenance package for use by the Army. The QMR should indicate the environmental conditions under which the equipment is to be operated. The test of the frequency scan radar was hampered because the military characteristics contained unrealistic and unattainable technical requirements.[23]

COMMODITY MANAGEMENT

Within the Army Materiel Command (AMC) command emphasis is being placed on commodity management. It was recognized that

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[23]US Army, US Continental Army Command, Military Characteristics for a Field Army Air Defense Coordination and Intelligence System (U), SECRET.

there was little justification for wide differences in the magnitude and type of such management found in subordinate commands of AMC. To begin elimination of these differences, AMC directed its subordinate commands to establish pilot commodity offices for management of certain items with intent to expand this plan in the future.

A facet of commodity management, and one which has not been emphasized sufficiently in the past, is that of early assignment to one command of overall responsibility for any developmental project requiring the coordinated efforts of several commands. In a simple Infantry weapon, development began in 1961 with seven developmental commands having important project inputs. It was nearly two years later when a command was designated to have the prime responsibility.

Assignment early of a commodity manager would assist in elimination of two characteristics which add to lead time. These are planning which proved to be over-optimistic and discovering of slippages after they had occurred. Proper and early commodity management with its inherent checks and required feed-back would detect those characteristics which not only increase lead time but also decrease quality of the product being developed.

ANALYSIS OF TESTING

This writer must disagree with the thesis which states that objective testing on the part of the US Army Test and Evaluation

Command (USATECOM) is difficult because of this command's subordination to the Army Materiel Command, which also has the developmental responsibility. USATECOM traditionally is commanded by a combat arms officer who has spent his service as a user of materiel. Further the great preponderence of his directorate chiefs are combat arms officers. All display a genuine devotion to obtaining the best items for the Army and have many successes to their credit.

CONDUCT OF TESTS

An engineering and service materiel test program may be conducted as an integrated, concurrent, or sequential test. Each of these methods of testing has its advantages and disadvantages; on occasion a combination of circumstances dictates the method used. Subsequent paragraphs address test methods and include advantages and disadvantages inherent in each particular testing mode.

An integrated test is often called a combined engineer-user test. In this type of testing, engineer and user formulate a joint test plan which incorporates the objectives necessary for suitable engineering and user judgments concerning the equipment.[24] It is really an exercise in compromise since neither engineer nor

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[24]US Dept of the Army, Test and Evaluation Command, USATECOM Pamphlet 700-700, p. V-8.

user is able to use the equipment totally in a manner which complements his objectives. Further, the location of the test is, of necessity, at either the engineer's facility or the user's testing ground; and division of funding and logistical requirements necessitate partial support from each. Although time is conserved since both testers accrue data from each test, time is lost in the coordination required throughout the test from writing joint test plan, through jointly executing the test, to composing final joint report of test. Human nature being what it is, neither engineer nor user is completely satisfied with the test report produced.

A concurrent test is one which requires separate testing, during the identical time period, by both engineer and user.[25] Separate test plans are written and coordinated; tentative findings and results are exchanged through reports and liaison visits. A major drawback to this mode of testing is that it requires two sets of equipment. Facilities of two separate installations are required, and the joint use of instrumentation is impossible. In addition, the monetary costs exceed those of a joint test. There is a large saving in time since engineer and user proceed unilaterally in accomplishment of their test objectives. Each tester is able to focus on his mission, perform a better test, assure that his judgments are unimpeachable.

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[25] Ibid., p. V-4.

Sequential engineering and service tests are conducted initially by the engineer.[26] After the engineer has completed his entire test, the equipment is furnished the user for test. The engineer test is conducted at the engineer's facility; the user test, at the location of the user. Separate plans and reports of test are published in sequence, one after the other. This mode of testing has the primary advantage of utilizing only one set of equipment.

The best way to test is concurrently, and certainly the poorest way is sequentially. Integrated testing falls somewhere between the two. Concurrent testing is by far the quickest, and saving time contributes to improving the cycle. The major drawback, requiring two sets of equipment, can be overcome by providing for two sets in the initial contract. At completion of tests, both sets are available for further use or deployment and are not lost to the Army.

User testing should be conducted on a continuous basis in consonance with the design of the equipment. Tests are normally conducted during an eight-hour work day. The day begins with movement of the equipment to the test site, and continues with preparation and conduct of test. As the end of the day approaches, the above process is reversed: the test is stopped, the equipment is prepared for movement and returned to its storage location.

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[26] Ibid., p. V-14.

If around the clock testing, seven days a week, were conducted, there would be no necessity for the daily exercise described above. The equipment would, on a continuous basis, be exercised until all of the test objectives had been achieved. This mode of testing would not only reduce time required for a particular test but also allow for more testing to be conducted during a particular time period. Its major shortcoming is the requirement for more test personnel. This requirement, though modest, could be held to a minimum by utilizing personnel (from school troop units and training centers) usually found at test locations when these troops could be made available without interference with the primary mission of their parent organizations.

BOARD TEST PERSONNEL

The qualifications of the personnel assigned to the test boards subordinate to USATECOM require examination. Several assigned officers have failed to be selected for promotion; others, near their twenty-year retirement goal, are anticipating the future. The responsibility of making the determination of whether an item is suitable for Army use is a sobering one, and test officers should be selected from among those professionals anticipating a long future using the materiel they test. They should meet the requirements set forth by Colonel Gailey for his subordinates of

the Operations Division during World War II when he put a premimum on speed, accuracy, and measuring up to exacting standards.[27]

ANALYSIS OF TYPE CLASSIFICATION

The technical committee system utilized for type classification has recently been improved by several changes in the system. A recent change to AR 705-5 has eliminated any pre-approval action on the part of the Department of the Army staff before type classification action is initiated. An expedited procedure using informal coordination between the Combat Developments Command and the Army Materiel Command on type classifications is being implemented. In addition utilization of concurrent rather than sequential approval channels has been effected. These recent changes to a complicated but effective system are reducing the time required for technical committee actions; and, because these changes have been implemented, they are not listed in the recommendations.

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[27] US Dept of the Army, Historical Division, United States Army in World War II. The War Department, Washington Command Post: Operations Division, p. 122.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The conclusions of this thesis are:

a. A uniform procedure for the staffing actions incident to timely establishment and approval of materiel requirements does not exist.

b. There is no formal procedure for the review and approval of proposed major changes in a system.

c. A firm Basis of Issue should be determined as soon as possible and always before Type Classification action.

d. A positive method is necessary to assure that materiel requirements are adequate, complete, and realistic.

e. Command emphasis should continue on commodity management.

f. US Army Test and Evaluation Command performs excellent, objective testing.

g. Engineering and user tests should be conducted simultaneously but independently.

h. User testing should be conducted continuously, in consonance with equipment design.

i. The qualifications of test board personnel need improvement.

RECOMMENDATIONS

Recommend:

a. A uniform procedure for the staffing actions incident to the timely establishment and approval of materiel requirements be established.

b. Institution of a formal procedure for the review and approval of proposed major changes in a system.

c. Determination of a firm Basis of Issue be made as soon as possible and always before Type Classification action.

d. Establishment of a positive method of assuring materiel requirements are adequate, complete, and realistic.

e. The conduct of engineering and user tests be simultaneous and independent.

f. User testing be conducted continuously, in consonance with equipment design.

g. The qualifications of test board personnel be improved.

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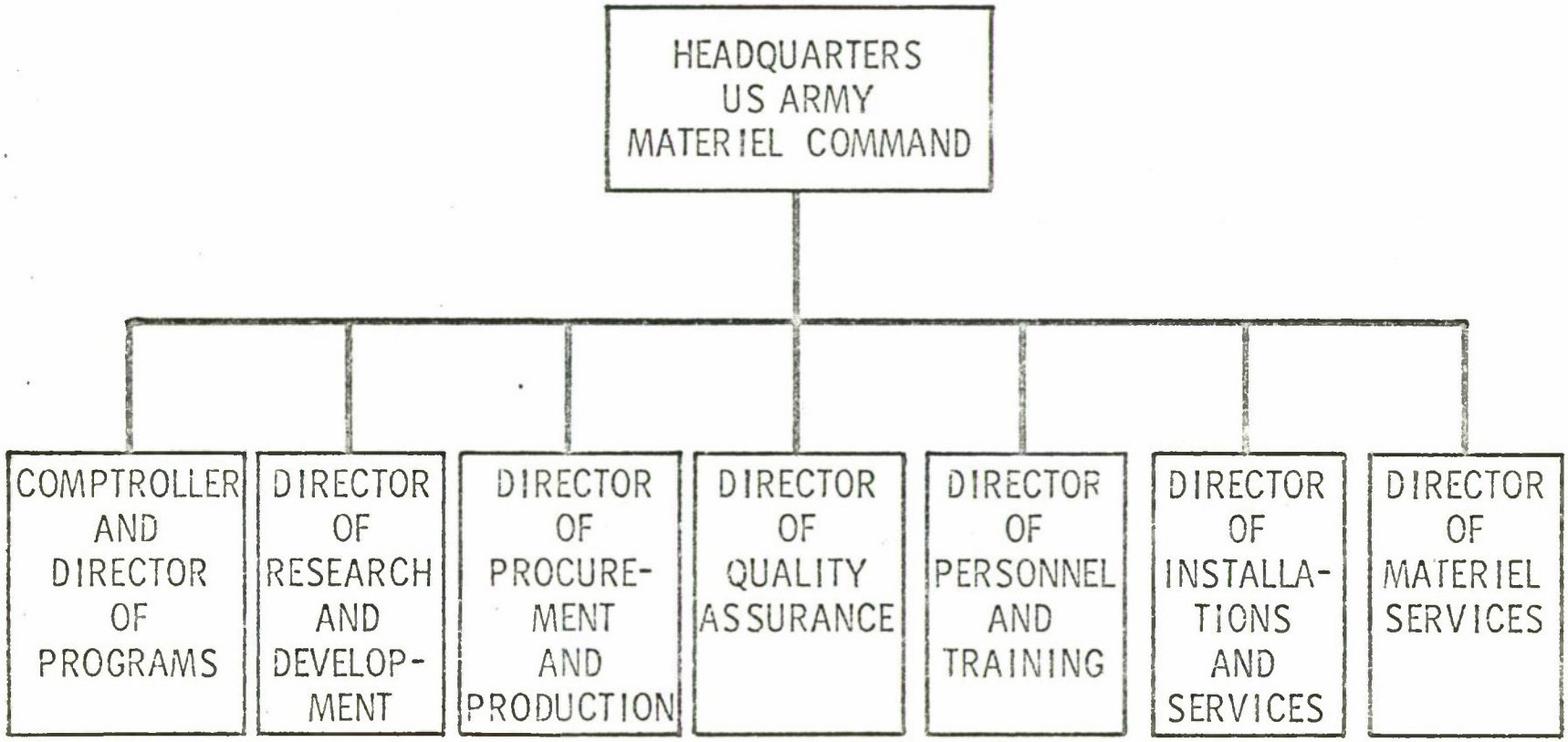
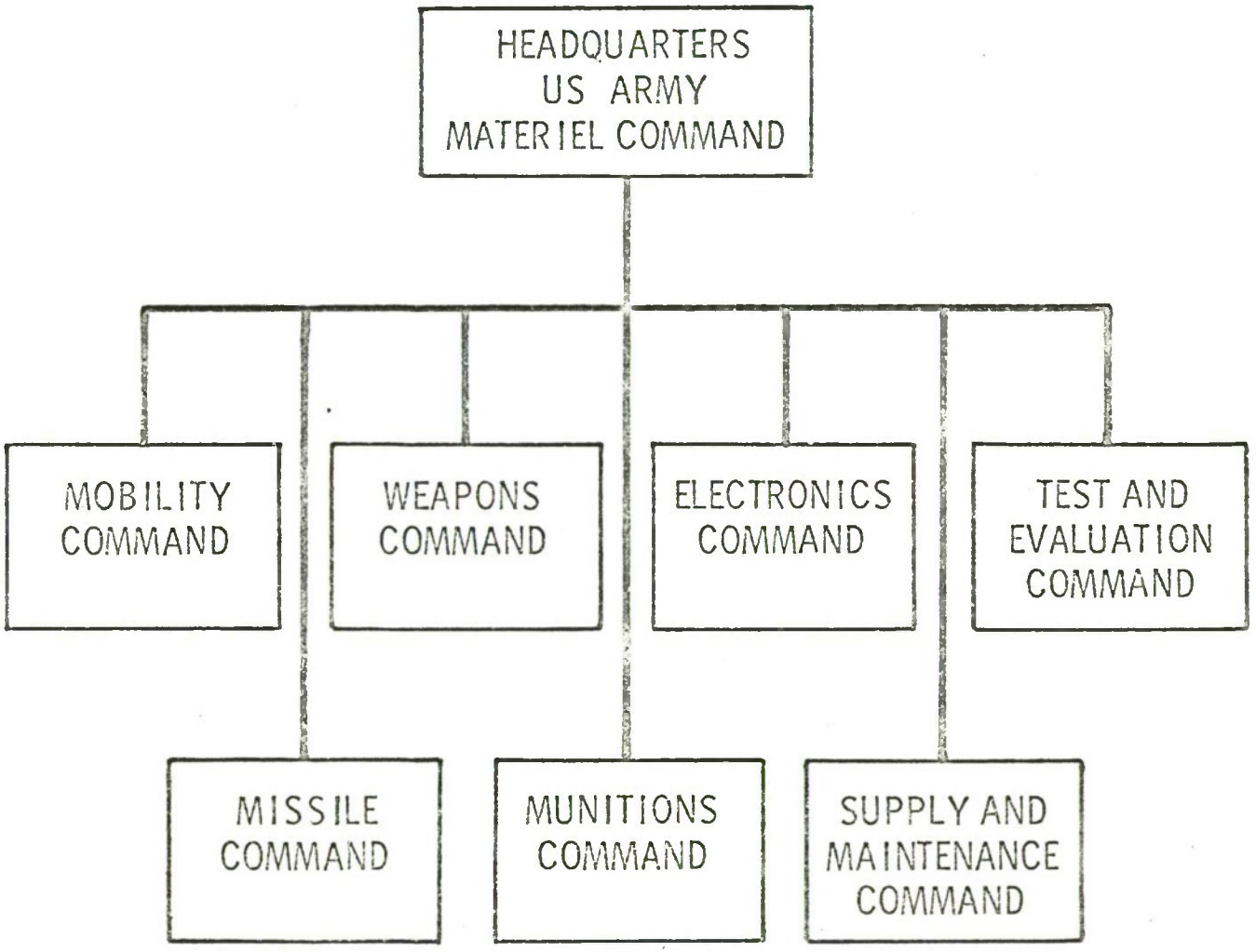
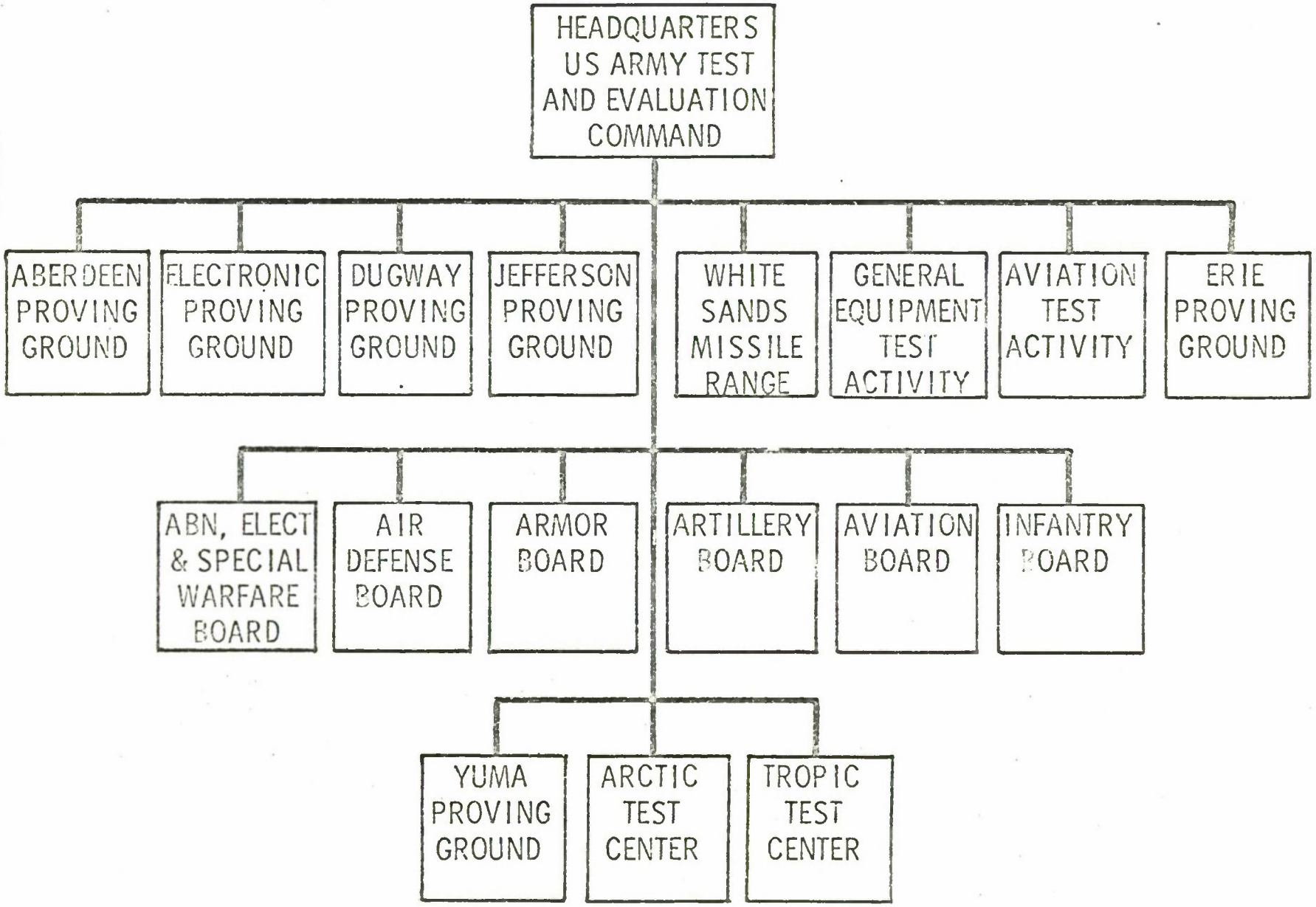


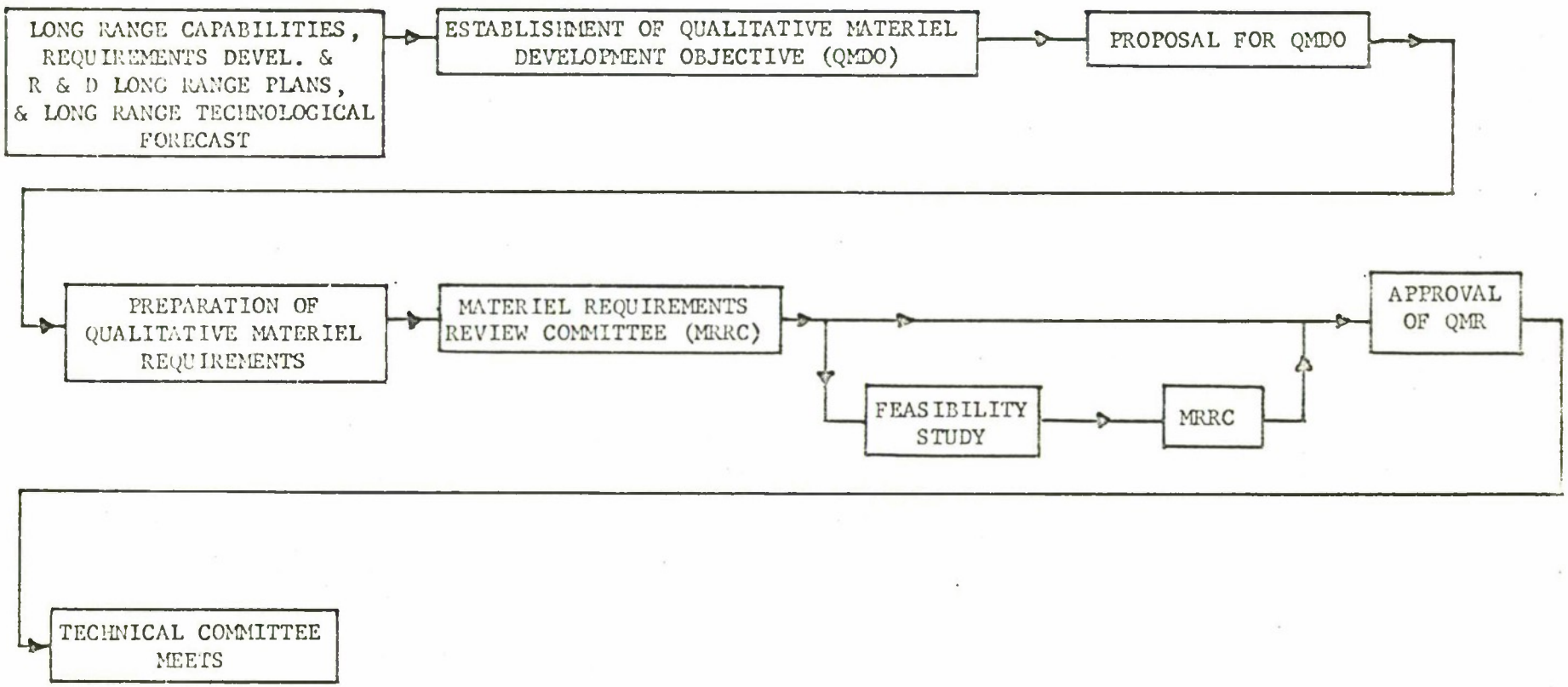
THE US ARMY MATERIEL COMMAND



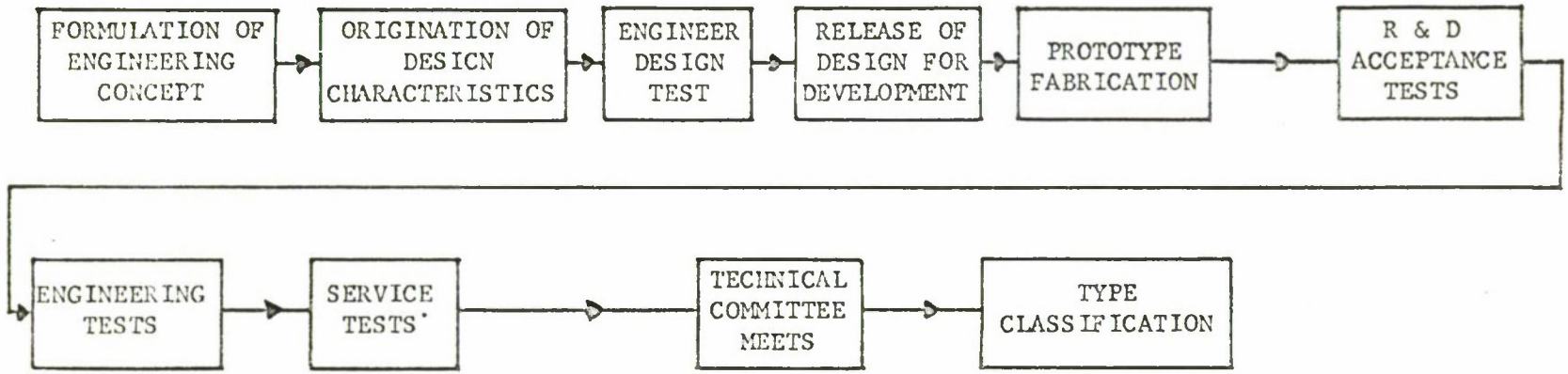
MAJOR SUBORDINATE COMMANDS OF THE US ARMY MATERIEL COMMAND



THE US ARMY TEST AND EVALUATION COMMAND



THE RESEARCH PORTION OF THE SCHEDULE OF RESEARCH AND DEVELOPMENT EVENTS



DEVELOPMENT PORTION OF SCHEDULE OF RESEARCH AND DEVELOPMENT EVENTS